Many-particle theory of all-optical polarization switching in semiconductor quantum wells

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All optical polarization switch: developed at Univ. Iowa (2002)

**Characteristics:**
- ultrafast (sub-ps)
- high contrast ratio (200:1)
- not yet room temperature (T=100)
- planar fabrication
- isotropic material

**Operation:**
- based on selective excitation of spin states

**Theoretical issues:**
- understanding of switching process with predictive theory
- identification of main many-particle process
- study of parametric dependencies of switch
- prediction of possible future optimization
Experimental Scheme

X Polarizer

E_{signal}

τ

Chopper

E_{control}

Pulse Shaper

MQW

Photodiode

Spectrum

Energy

control

hh

signal

lh
Band structure & selection rules

X-polarized signal field: equal-strength $\sigma^+$ and $\sigma^-$ transition (no rotation)

“+” polarized control field $\Rightarrow$ unequal $\sigma^+$ and $\sigma^-$ transitions
$\Rightarrow$ elliptical polarization of signal output
Time-integrated signal

**Experiment**

<table>
<thead>
<tr>
<th>Contrast Ratio</th>
<th>Degree of polarization</th>
<th>Ellipticity, $\varepsilon$ (degrees)</th>
<th>Azimuth, $\theta$ (degrees)</th>
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Control irradiance
24 MW/cm²

Polarization ellipse

**Theory**